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SOME ENEMIES OF TRUCK AND GARDEN CROPS.

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

AND STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

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The growing of early vegetables for the Northern markets has become one of the most important and best paying branches of farming in the State. The recently compiled census shows that for the South Atlantic District, of which North Carolina forms a part, the average net profit per acre for each of the principal truck crops is as follows:

Asparagus, $93.63; Beets, $95; Snap Beans, $42 94; Cabbage, $113.61; Cucumbers, $175; Watermelons, $32.06; Canteloupes, $55; Peas, $57.37; Irish Potatoes, $101.60; Sweet Potatoes, $106.50; Spinach, $70; Tomatoes, $94.72.

It is believed that in North Carolina, for good average seasons, the net income per acre for each of the above crops exceeds rather than falls below these figures. It is certain that the possible profits of truck-farming are largely decreased by reason of the losses caused by insects and disease-producing fungi. The yearly loss to the State on this account does not fall below $50,000, and very likely exceeds this amount. Economic botany and entomology have provided very efficient remedies for the more dangerous insect and fungus pests. These remedies, if judiciously applied, in connection with hygienic precautions, cannot fail to reduce this loss to one-fourth, or less, of its present proportion.

To furnish our truck-farmers, and all who grow vegetables, with the most approved methods for protecting their crops and increasing their profits is the purpose of this Bulletin. The present Bulletin deals with the insect and fungous enemies of truck crops only. A later Bulletin will treat of the pests of orchard and vineyard.

For the cuts used in this Bulletin, except those of apparatus, we are indebted to the U. S. Department of Agriculture.

H. B. BATTLE,
Director.

SOME ENEMIES OF TRUCK AND GARDEN CROPS.

By GERALD McCARTHY, Botanist and Acting Entomologist.

I.

The growing of vegetables for Northern and local markets has become one of the most extensive industries of North Carolina. Anything that tends to restrict the number or area, or diminish the profits of these crops, is of no small consequence to the prosperity of the State at large. All of the crops usually called "truck" are more or less subject to damage from fungous and insect pests.

A circular of inquiry sent to truck-farmers this spring elicited the information that the truck crops most damaged by fungous or insect enemies are as follows: Snap-beans, summer cabbage and collards, celery, cucumbers, melons, Irish and sweet potatoes, strawberries and tomatoes.

Formerly, when less was known of microscopic organisms, plant diseases were attributed solely to changes of the weather. We now know that these diseases are caused by parasitic plants whose spores, or seeds, obtain access to the growing crops. Without the presence of these spores no change in the weather can cause such diseases.

II.

The rusts, rots, blights and mildews of growing crops are caused by different species of parasitic fungi. These fungi are themselves plants, but so small as to be invisible to careless observers, and their presence is usually overlooked until it is proven by their work. This generally becomes apparent only when too late to save the crop. The astonishing power of multiplying their species possessed by these organisms much more than counterbalances their small size. Fungi differ physiologically from the higher forms of plant life, in that they possess no chlorophyl, the green-coloring matter of plants. It is the possession of chlorophyl that enables the higher forms of plants to decompose the mineral compounds of the soil and the carbonic acid gas of the air and transform their elements into organic compounds, wood, fruit, oils, sugar, etc., etc. Fungi, not being able to feed upon minerals, fasten themselves upon green plants, and from these unwilling hosts they suck the nutritious juices elaborated in the leaf cells of the host plants. These parasites propagate their species by means of spores, or seeds, of which a great many generations are produced each season. The spores are so small that they are borne about by even the slightest breeze, and are thus carried to infect new host plants, to whose interior they obtain access through the breathing pores of the leaves and branches. These spores also exist in the infected roots left in the ground from a preceding crop,

and in many cases obtain entrance to the cells of the host plant by means of the growing roots of the latter. The spores of fungi are, as a rule, capable of sprouting only in the presence of moisture and a rather high temperature. There is, therefore, no growth or increase of fungi during the winter, or during very dry weather in summer. The dormant spores are able to live through even the coldest weather. These spores exist in countless millions in the diseased leaves which litter the ground in infected orchards, vineyards and gardens, and in the roots and tubers of diseased vegetables which have been left in the ground. Knowing these facts we can, by taking proper measures, greatly diminish the number of spores, and, therefore, the evil power of these pests. This is what is meant by disinfection and field hygiene.

It is well known to botanists, and cannot be too thoroughly understood by farmers and gardeners, that when the spores of parasitic fungi have obtained access to the interior of the host plant they cannot be dislodged. All successful treatment of fungus-caused plant diseases *must be preventive*. Such treatment should be chiefly hygienic —disinfection of the field, garden and orchard by burning diseased plants and leaves. Under this head, too, we must include the proper selection of soil suitable for different classes of plants, and of varieties of plants suitable for any particular climate, and the proper fertilization and care of the plants while growing. No plant can long remain healthy in uncongenial soil or climate, or where plant food is deficient, or where the plants are permitted to over-bear themselves, or where planted too close to insure abundance of air and sunlight.

Among topical remedies we include fungicidal washes and powders. It is now very generally known that the salts of copper, more especially copper sulphate (bluestone), are powerful fungicides. These substances are now very largely used in the form of liquids, such as the Bordeaux mixture, etc., etc. There is apparent a tendency to trust too much to the fungicidal power of these substances, to the neglect of hygienic measures. Let it be known, then, that the power of copper salts to destroy young absorbative vegetable tissue applies to the rootlets of useful green plants as well as to the sprouting spores and root parts of fungi. These salts are not friends to be trusted implicitly and without limit. They are necessary evils, to be used with the utmost caution, and in the smallest effective quantities. Nearly all the copper salts sprayed upon plants eventually finds its way into the soil, and experiments have shown that when the soil has received a considerable amount of copper sulphate it decreases in fertility, and it is probable that the application of a ton or so of this substance to one acre would completely sterilize the soil so that not even a weed or a blade of grass will grow thereon. Of course, no one would apply so large a quantity at one time, but it must be remembered that copper, in whatever form it may be supplied, remains in the soil, and a small amount often repeated will, in the

course of years, assume large proportions. It is unwise, then, to look only to the present effect and neglect the future consequences of the use, in field or garden, of substances destructive to plant life. Still, it would be equally unwise to permit disease-causing fungi to destroy our current crops. The safest plan is to place our main reliance upon hygienic measures, and then use fungicidal mixtures with discrimination and care.

Since we know that the spores of disease-causing fungi lie dormant through the winter in the diseased leaves and roots of the preceding crop, we must see the necessity of cleaning up the fields and the destruction by fire or prolonged boiling of this infectious material with the contained spores. This is more particularly the case with perennial crops, which cannot be rotated. Many prudent farmers are accustomed to save all vegetable refuse and plow it under to supply humus to the soil. This is good policy where such refuse is free from disease germs, but of late years noxious fungi have increased and become so common everywhere that it will be the safer plan to burn all dead leaves and prunings, and to remove from the soil and destroy, by means of quick-lime or fire, all diseased roots of cabbage, turnips, potatoes, etc. Such diseased matter should not be fed to stock without being previously boiled to kill the spores, as otherwise the spores will pass unharmed through the animal and be carried out upon the land in the manure. We know, too, that the larger number of species of parasitic fungi are restricted to a single species of host plant, and therefore may be starved out of any soil by rotating crops so as to keep the soil free for two or three years from the crop liable to infection.

III.

We have already explained that copper salts are active and convenient fungicides, but must be regarded as necessary evils in the garden and field. Of several evils it is wise to choose the least, and therefore efficient fungicides which contain the least copper salts are always to be chosen. Substances like glue and molasses, sugar and starch, which adhere to foliage, should be added to all such mixtures in order to prevent them from being too easily washed off the plants by rain or dew. The following formulas can be recommended as efficient fungicides. Some are good for general use, while others are efficient only for particular crops. The proper formulas to use will be given under each particular disease

FUNGICIDES AND INSECTICIDES.

Formula No. 1.—Iron Sulphate.

Iron sulphate (copperas)	2 pounds.
Hot water	5 gallons.
Glue, half pint, or molasses	1 pint.

Directions.—Dissolve the iron sulphate in the water, then stir in the dissolved glue or molasses, and use while hot. One-half ounce of Paris green or London purple may be added to each 5 gallons.

Formula No. 2.—Potassium Sulphide.

Potassium sulphide	4 ounces.
Fresh lime	½ pound.
Paris green	½ ounce.
Glue, half pint, or molasses	1 pint.
Water	8 gallons.

Directions.—Dissolve the potassium sulphide in 4 gallons of water. Sprinkle the Paris green or London purple upon the lime, and pour over it one gallon of water. When slaked stir until all lumps are broken, and then strain the lime and arsenite into the sulphide. Stir in the molasses and use. When insect enemies are not feared, the lime and Paris green may be omitted.

Formula No. 3.—Improved Bordeaux Mixture.

Copper sulphate (bluestone)	1 pound.
Fresh lime	1 pound.
Molasses or liquid glue	1 pint.
Water	10 gallons.

Directions.—Dissolve the sulphate in a wooden, glass or earthenware vessel in 5 gallons of water. In another vessel slake the lime in 1 gallon of water. Rub lime until all lumps have been broken, then strain and stir slowly into the sulphate; never pour the sulphate upon the lime. When all ebulition has ceased add the molasses and use. One ounce of Paris green or London purple may be added to each 10 gallons of this mixture. When the arsenite is used it will be best to sprinkle it upon the lime before slaking the lime.

Formula No. 4.—Sulphur Powder.

Sulphur flour	4 pounds.
Air-slaked lime, fine ashes or road dust	8 pounds.
Wheat flour	1 pound.

Directions.—Mix and use dry. One-half ounce of Paris green or London purple may be added to each 13 pounds of the above mixture.

Formula No. 5.—Copper-Sulphur Powder.

Precipitated carbonate of copper	1 ounce.
Sulphur flour	5 pounds.
Air-slaked lime	10 pounds.
Wheat flour	1 pound

Directions.—Mix dry and use. Two ounces of Paris green or London purple may be added to each 13 pounds of the above mixture.

Formula No. 6.—Arsenites, Liquid.

Paris green or London purple	1 pound.
Flour boiled into a paste	5 pounds.
Quick-lime	5 pounds.
Water	150 to 200 gallons.

Directions.—Pour the Paris green or London purple upon the quick-lime and then add water enough to slake the lime and strain. Dilute to the required strength by adding water, then stir in the paste and use.

FORMULA No. 7.—ARSENITES, POWDER.

Paris green or London purple	1 pound.
Wheat flour, or powdered tale (soapstone)	5 pounds.
Air-slaked lime, fine ashes or road dust	50 pounds.

Directions—Mix dry and use.

FORMULA No. 7.—KEROSENE EMULSION.

(A.—COOK'S FORMULA.)

Soft soap	1 quart.
Water	2 quarts.
Kerosene oil	1 pint.

Directions.—Boil the soap in the water until entirely dissolved. Remove from fire and add the kerosene. Churn the soap solution and oil for ten minutes, or until *thoroughly* emulsified, or force the oil and soap through a spraying-pump three or four times, spraying it back into the same vessel. When properly done the oil will not separate from the soap after cooling. One-fourth pound of hard soap may be used instead of a quart of soft soap. Dilute the emulsion with its bulk of cold water before using.

(B.—RILEY'S FORMULA.)

Hard soap	½ pound.
Water	1 gallon.
Kerosene oil	2 gallons.

Directions.—Boil the soap in the water until all dissolved. Remove from fire and add the oil. Churn for ten minutes, or spray back into the vessel until thoroughly emulsified. Dilute with nine parts of cold water to one of the emulsion before using. These two formulas are about equally effective, but the (A) formula is easier prepared and will be the one most frequently used by farmers. This is the best of all remedies for plant-lice and soft, smooth "worms," while they are young.

FORMULA No. 8.—TOBACCO DECOCTION.

Tobacco stems or powder	1 pound.
Water	3 gallons.

Directions.—Boil the tobacco in the water for one-half hour, replacing water evaporated. Cover and set aside until cool, and use without dilution. This is one of the best remedies for "red spider" and plant-lice on cabbage and other plants, and if to each 3 gallons is added 1 pound of precipitated sulphur, or flour of sulphur, the effect will be all the better.

FORMULA No. 9.—CARBOLIC WASH.

Crude carbolic acid	1 tablespoonful.
Water	1 gallon.

Directions.—Add the acid to the water and stir until well mixed. Use without further dilution.

FORMULA No. 10.—KEROSENE POWDER.

Kerosene oil	1 tablespoonful.
Gypsum, or air-slaked lime	4 pounds.

Directions.—Pour the oil upon the gypsum or lime and mix thoroughly. Use without further dilution.

The materials for compounding these formulas can be purchased of any druggist, but the prices of retail druggists are, as a rule, double what the same chemicals can be purchased for in larger quantities from large manufacturers. The State Business Agent of the North Carolina Farmers' Alliance can supply, at very low prices, most of the chemicals mentioned in these formulas. They can be had, also, of W. S. Powell & Co., Baltimore, Md., and of the Nichols Chemical Co., 34–36 Cedar street, New York. Those needing spraying chemicals should write for prices to the above-named dealers. This Experiment Station, of course, has no chemicals for sale or distribution, and no orders for such should be sent here.

IV.

To use fungicides with economy and success suitable implements are necessary for distributing the spray or powder just where it is wanted, and in the proper condition. A very small quantity of the fungicide distributed in a mist-like spray, or fine powder, is much better than a heavier application. The foliage does not require to be drenched with the liquid or plastered with the powder. When nozzles throwing a heavy spray are used the greater portion of the liquid rolls off the leaves and falls upon the ground. The finer the spray the closer it adheres to the foliage. A thoroughly good sprayer or duster should be used. Happily, there are several such implements now on the market at very reasonable prices. There are also many implements advertised as "cheap." These, as a rule, cannot be endorsed. Among the heavy barrel-pumps advertised in the papers there are several cheap affairs which have iron cylinders and rods and leather valves. Copper sulphate soon corrodes iron and destroys leather. Such pumps are certain to give dissatisfaction, and are dear at any price. *Buy only all-brass, ball-valved pumps*, whatever the price. The nozzle is a vital portion of a spraying pump. Many of the nozzles sold, such as the solid stream "Boss," "Graduating," etc., are not to be recommended. The Vermorel lance for liquids, containing lime, and the "Climax," for clear or thin liquids, are by far the best, and it will pay to have both these styles of nozzle.

There are three classes of sprayers on the market—

1. Knapsack sprayers, holding 4 to 6 gallons, to be carried on the back of user. Price, $12 to $18.

2. Barrel sprayers, holding 40 gallons, to be drawn in a hand or horse-cart and worked by hand-power. Price, $12 to $20.

3. Large tanks on wheels, worked by gearing from the axles. Price, $65 to $100.

For general purposes, and for vineyard and garden use especially, the knapsack style is the best. This is easily portable, and, in most cases, extension rods can be fitted to the end of the hose, so that even trees fifteen feet high can be sprayed. This style is, however, not recommended for orchard use, as the power used to throw the spray over a tree will soon jar the pump loose from the tank, and is, moreover, hard upon the back of the bearer. Where much spraying is done a great deal of time is consumed in refilling tank of knapsack sprayer. The barrel pump is the best for orchard use. The barrel holds enough liquid to cover a large area, and hence less time is lost

in refilling. These pumps are powerful enough to throw a stream forty feet from the nozzle, and by using a piece of gas pipe as an extension of the hose, the spray can be forced to the highest part of any tree. This class of pump is usually strongly made, and will, with care, last many years and do hard work. The horse-power sprayers are expensive and of doubtful efficiency. An intelligent man is wanted at the end of the hose to apply the fungicide just where it is wanted, *and nowhere else*, and this automatic sprayers cannot do. The Station does not recommend this class of sprayers.

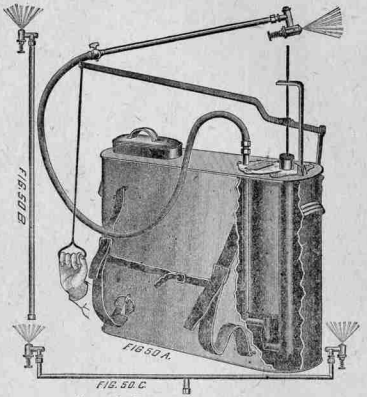

Fig. 1.—THE GARFIELD KNAPSACK SPRAYER.

The "Garfield" knapsack sprayer, made by the Field Co., Lockport, N. Y., is one of the most useful general-purpose sprayers on the market. It is very strongly made of brass and copper, and will throw a stream over a tree ten feet high. This sprayer has the Vermorel lance nozzle. It has an extension rod (B), and also a special T rod (C) for spraying, at the same time, two rows of potatoes, tobacco, etc. It will throw the spray either upwards, so as to strike the under side of the leaves, or downwards upon the upper side of the leaves. This sprayer costs $14 at retail, but is sold to farmers at

wholesale prices, by W. H. Worth, of Raleigh, State Business Agent of the N. C. Farmers' Alliance, who can also furnish other sprayers and fungicidal and insecticidal chemicals at wholesale prices.

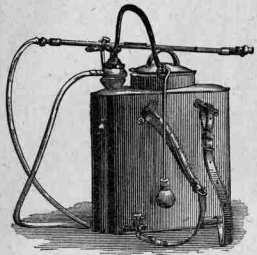

Fig. 2.—GALLOWAY KNAPSACK SPRAYER.

The "Galloway" sprayer is one of the most efficient portable sprayers offered. It is well made of brass and copper and has the Vermorel nozzle. It is made by Albinson & Co., Washington, D. C., and sold at retail for $14. It is sold for less to Alliance members by the State Business Agent of the Alliance.

For orchards and large fields, where a horse can be conveniently driven, the heavy sprayers will be found most useful. Among the best of this class is the "Perfection" (Fig. 3), made at Lockport, N. Y., by the Field Pump Co. This pump, all brass, retails for $12, but is sold to farmers at wholesale prices by W. H. Worth, Raleigh, N. C.

Fig. 3.—PERFECTION SPRAYER.

The "Eureka" knapsack (Fig. 33) is one of the best of this pattern, but a little heavier than either the Garfield (Fig. 1) or Galloway (Fig. 2). The "Eureka" is made at Philadelphia, Pa., by Wm. Boekel & Co., and retails for $18. See page 21 for cut.

Fig. 4.—THE "EMPIRE" CART SPRAYER.

The "Empire" hand-cart sprayer (Fig. 4) is an excellent implement for orchards and fields, where it is not desirable to take a horse. This sprayer retails for $19, and may be ordered from W. H. Worth.

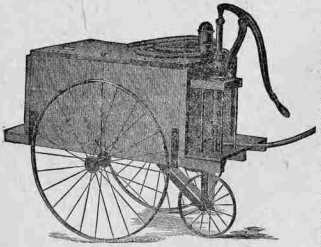

Fig. 5.—"LITTLE GIANT" SPRAYER.

The "Little Giant" (Fig. 5) is made both for hand and horse-power. The hand-power machine is a good one, the tank holding 40 gallons. Price, $35. The horse-power machine is worked by gearing from the axle. Price, $85. Made by the Nixon Machine Co., Dayton, O.

The "Climax" barrrel-pump, made by the Nixon Company is one of the best of this style This is to be drawn in a horse-cart, or a hand-cart (as shown in Fig. 5) can be attached. Its retail price is $14.

Fig. 6.—THE "CLIMAX" PUMP.

Fig. 7.—"DOUBLE-ACTING" PUMP.

The "double-acting" brass pump shown at Fig. 7 is made by W. & B. Douglass, Middleton, Conn., and by most of the manufacturers of heavy sprayers. Its cost, all brass, is from $8 to $10, and it is a very efficient pump when a good nozzle is used.

The Woodason double-cone bellows is a very satisfactory implement for blowing powders. It is made at Philadelphia, Pa., by Thomas Woodason, and retails at $3.

Fig. 8.—WOODASON BELLOWS.

Fig. 9.—WOODASON ATOMIZER.

The Woodason atomizer is the best implement we know of for spraying a small number of plants and for use in-doors. It throws a much finer spray than any of the above-mentioned sprayers. This atomizer is made by the maker of the bellows. It sells for $1.50.

V.—FUNGI, INSECTS, AND REMEDIES.

1.—BEANS.

North Carolina grows annually about 860 acres of snap-beans. The annual loss from disease will average 10 per cent. of the total yield. The most troublesome disease of the bean is that called "rust," "pod-blight," or anthracnose. This disease is caused by a parasitic fungus known to botanists as *Gleosporum Lindmuthianum*. The wax varieties are especially subject to this disease, particularly when grown on wet soil, or when so close together that the plants fail to get enough air. Hot weather greatly increases this disease.

TREATMENT FOR POD BLIGHT.

1. Plant only on well-drained soil.
2. Plant thinly enough to insure plenty of air and sunlight.
3. Gather all diseased pods and burn or compost them with lime.
4. Spray with Formulas Nos. 1 or 2, omitting the Paris green, or dust with Formulas Nos. 4 or 5.

As this disease is contagious (catching), when it is known to be in the neighborhood bean-growers should begin to spray as soon as the flowers have withered, whether there is any sign of disease or not.

There is another bean disease called "leaf-spot," more common on climbing beans. This is caused by a parasitic fungus known as *Uromyces appendiculatus*. The treatment recommended for pod-blight will answer equally well for leaf-spot, but should begin as soon as the leaves are well grown.

Snap beans are not damaged to any considerable extent by insects except wire and cut-worms. Wire-worms eat the seed beans in the ground, and cut-worms cut off the young plants as soon as they have come up. Wire-worms are the larval form of several species of clicking beetles, which, as beetles, live in rotten wood, and therefore such should be kept out of bean-fields. Cut-worms are the larval forms of several species of night-flying moths. The best preventive of these is to spray Paris green upon green succulent vegetation of any kind, especially clover and cabbage leaves. Dust upon these some wheat flour and roll the leaves into a ball and tie. Prepare the field at least a week before planting the beans and distribute the poisoned balls throughout the field, say, 10 feet apart. The worms, coming to the surface and finding no growing plants, will eat the poisoned baits. The baits must be renewed when withered. A shingle may be placed upon each ball to keep it moist.

Fig. 10.—GREASY CUT-WORM.

Fig. 11.—PARENT MOTH OF CUT-WORM.

2.—CABBAGE.

North Carolina grows for market about 825 acres of cabbage. The loss from disease and insects is sometimes heavy. Early spring cabbage and that grown late in the fall are less damaged than summer cabbage. The most common and destructive disease of cabbage is that called "stem-rot," or "blight." This disease may be caused by either of two species of parasitic fungi, viz.: *Peronospora parasitica* and *Cystopus candidus*. Generally both of these are found together. Whole fields of fine-looking cabbage beginning to head have been reduced to putrifying stumps by this disease in a week. This disease attacks turnips, mustard, kale, collards and various weeds belonging to the collard tribe, especially "shepherd's purse," or "pepper-grass."

TREATMENT FOR CABBAGE-BLIGHT.

1. Grow only very early and very late cabbage.
2. Never plant cabbage after cabbage or turnips on same field.
3. Keep fields clear of "pepper-grass," charlock and cress.
4. Remove and burn, or compost with lime, rotten stumps and heads.
5. Apply to plants in seed-bed Formulas 1, 2 or 4, and repeat several times after transplanting to field.

Scarcely second to "blight" is the disease called club-root. This is caused by a parasitic fungus, *Plasmodiphora brassica*. It also attacks turnips, mustard and other plants of the cabbage tribe. Cabbage plants are very often infected in the seed-bed. The fungus lives through the winter in diseased roots left in the ground. As this fungus attacks only the underground part of the plant no application to the leaves will do any good. Lime in the soil has been found a preventive of club-root.

TREATMENT FOR CLUB-ROOT.

1. Make seed-bed upon soil which has not before grown cabbage.
2. Apply a heavy dressing of air-slaked lime to seed-bed.
3. Carefully reject all seedlings showing club-roots.
4. Dip seedlings into limewater when setting out.
5. Rotate crops so as to have cabbage on same field not oftener than once in 3 years.
6. Avoid use of superphosphate for cabbage. Bone meal, lime and marl may be used.

The insect enemies of cabbage are both numerous and destructive. The most troublesome of these are the striped and green worms, which are the larval form of the white and yellow butterflies, *Pieris crapæ* and *P. oleraceæ*, so plentiful in the cabbage-field. A night-flying moth, called the CABBAGE PLUSIA, *Plusia brassicæ*, is the parent of the slender, greenish span-worm which, in some districts, is even more common than the above.

Fig. 12.—CABBAGE PLUSIA.

Paris green or London purple will kill the worms, and there is no reason why this may not be used before the plants begin to head, but these, being dangerous poisons, must not be used upon headed cabbage. The kerosene emulsion (Formula 7) is, upon the whole, the safest and surest remedy. Some growers have had great success with the carbolic wash (Formula 9). Either of these liquids, to be effectual, must be thrown with sufficient force to strike the skins of the worms in spite of the hairy covering.

Fig. 13.—CABBAGE CATTERPILLAR.

The TERRAPIN BUG, or CALICO BUG, *Murgantia histrionica*, has become even a greater pest than the cabbage worm. This insect seems proof against all known or practicable insecticides. Hand-picking must therefore be resorted to. This insect passes the winter in the ground and only a few survive, but these are so prolific that the few quickly become a multitude. Hand-picking, to be effectual, must therefore begin early and be repeated at least twice a week. The eggs, which are white with a black band, and set on end like small barrels, are easily seen and should be picked off.

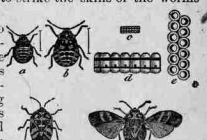

Fig. 14.—TERRAPIN BUG.

The best way to hand-pick insects and "worms" is to use a shallow, oblong pan; a sheet-iron bread-pan will do. Put an inch or so of water into this and upon the water pour a film of kerosene oil one-quarter inch deep. Hold the pan in one hand, and, with the other

bend over the infested plant and shake with sharp jerks. Most of the bugs or "worms" will fall into the pan and be instantly killed by the oil. The eggs cannot be so easily dislodged. They must be picked off with the fingers and thrown into the pan. The oil will kill the eggs also.


Fig. 15. FLEA BEETLE.

The FLEA BEETLE, or Turnip Fly, *Graptodera sp.* and the cabbage louse, *Aphis brassica*, are dangerous enemies. These are sucking insects, and Paris green has no effect upon them. The kerosene emulsion, carbolic wash and tobacco decoction are the best remedies. It is always best to apply insecticides which kill by touch, as is the case with all three of the above, early in the morning before sunrise. At this time the insects are sluggish on account of the cool night air, and are therefore more easily struck by the spray.

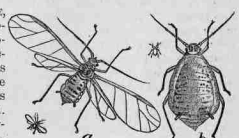

Fig. 16.—CABBAGE LOUSE.

3.—CELERY.

Celery is not as extensively grown in North Carolina as it might be. Many who grow it on upland soils complain of severe loss from "blight," and some complain of the ravages of a grasshopper-like insect. Celery is naturally a bog plant, and cannot be successfully grown on upland soil without irrigation. It is also naturally fond of shade, as in its wild state it grows among tall reeds.

Celery blight is caused by a parasitic fungus known as *Cercospora apii*. This fungus attacks the leaves only. It passes the winter in the old diseased leaves commonly left on the ground. It usually infects the young plants while yet in the seed bed. Kainit is one of the best fertilizers for this crop, and seems to act as preventive of blight in some cases. The crop cannot be kept healthy without plenty of water.

TREATMENT FOR CELERY BLIGHT.

1. Make seed-bed under shade of trees or use a screen of laths.
2. Do not transplant to field until late in the season.
3. Plant some shading crop, such as Russian sunflower, among the celery in the field.
4. Carefully destroy all diseased leaves.
5. Apply to the plants in seed-bed and after transplanting Formulas Nos. 2 or 4.
5. For insects which may attack celery apply the kerosene emulsion or tobacco decoction.

4.—MELONS.

Melons, squashes and cucumbers are closely related plants, and have about the same fungus and insect enemies. All of these crops are largely grown in North Carolina. Melons and squashes suffer from a disease called "blight," which is caused by the same parasitic fungus which causes the "pod-blight" of beans. The treatment must be the same in both cases, and need not be recapitulated here. Since these crops suffer from the same disease they are not suitable for following each other in rotation.

Melons, squashes and cucumbers are all attacked by a small grayish bug, called SQUASH BUG, *Anasa tristis*. Paris green or London purple is the best remedy.

The STRIPED CUCUMBER BEETLE, *Diabrotica vittata*, is one of the most inveterate pests of the cucumber, melon and squash. *Diabrotica 12-punctata* is also a pest of melons as well as most other garden crops. Dusting the plants with the kerosene-lime powder (Formula 10) has been found in many cases a preventive. Paris green may be used also. Hand - picking must be resorted to if necessary.

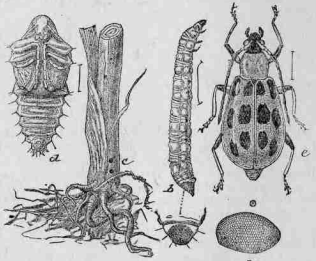

Fig. 17.—DIABROTICA 12-PUNCTATA. *a*. Egg magnified. *b*. Larva. *c*. A bored root. *d*. Pupa. *e*. Adult. (After Riley.)

When these plants are grown on a small scale it has been found satisfactory to fence out the beetle by means of a piece of gauze held over the plant by a half-hoop, whose ends are pushed into the soil. The edges of the cloth must be covered with soil, so that the beetle cannot get under.

5.—IRISH POTATO.

North Carolina grows annually about 1,500 acres of Irish potatoes. This plant has numerous fungus and insect enemies, and the annual loss to the State on this account must be over $10,000.

The most dreaded enemy of the potato is the "blight." This disease is caused by a parasitic fungus, *Phytophthora infestans*. The fungus passes the winter in the ground where a diseased crop grew; in the diseased vines, and in the stored tubers.

TREATMENT FOR POTATO BLIGHT.

1. Use only sound seed potatoes.
2. Rotate the crop so potatoes shall not come on the same field oftener than once in three years.
3. Apply to growing vines Formulas Nos. 1, 3 or 5.
4. Burn all dead potato vines, whether diseased or not.

Fungicides for potato blight should be applied as soon as the plants are six inches high, and repeat as often as the powder is washed off. Usually five or six sprayings will be needed.

Next to "blight" the worst pest of the potato is "scab." Scabbing of potatoes has now been shown to be the work of a parasitic fungus, but the fungus itself has not yet been satisfactorily identified. It has been noticed by most growers that stable manure seems to increase the amount of scab in the crop. The use of scabby seed potatoes and the plowing under of dead potato vines are the means of rapidly spreading the disease.

TREATMENT OF POTATO SCAB.

1. Use only seed potatoes free from scab.
2. Rotate crops so as to starve out the fungus.
3. Avoid using stable manure on potato ground.
4. Burn all dead potato vines.
5. Soak the seed potatoes before planting for 20 minutes in Formula No. 2, or dust on the cuttings before dry Formula No. 4.

The COLORADO BEETLE, or POTATO BUG, *Doryphora decemlineata*, is the most common insect enemy of the potato. Paris green or London purple is a certain remedy.

The BLACK BLISTER BEETLE, *Cantharis Nuttallii*, is, in some districts, very troublesome. It can be readily checked by Paris green.

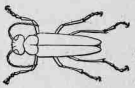

Fig. 18.—BLACK BLISTER BEETLE

The Flea Beetle (see Fig. 15) attacks potatoes also. Remedy, kerosene emulsion or tobacco decoction.

In using any of the fungicidal formulas recommended for spraying or dusting on potato vines, the amount of arsenite stated under the formulas should always be added, and thus fungi and other insects be provided for at one operation.

6.—SWEET POTATO.

North Carolina grows for market about 800 acres of sweet potatoes. Of recent years this crop has begun to suffer from a disease called "black rot." This disease is undoubtedly caused by a parasitic fungus, but the life history of the fungus is not yet sufficiently known to enable us to prescribe special treatment. Only general and hygienic treatment is as yet possible. Rotation of crops, burn-

ing of old vines, removal and destruction of diseased tubers are the most useful measures. Only sound tubers should be used for producing "slips." The "slips" of the sweet potato are frequently infected in the sprouting bed. These when pulled show black spots or blotches. Such slips should at once be destroyed, as they are certain to produce diseased tubers, if any at all. It will be a useful precaution to plunge the root ends of the "slips" into a vessel of lime-water before planting.

The sweet potato is remarkably free from insect enemies. Those most common are the so-called TORTOISE BEETLES, *Cassida bivittata*, and other species. Paris green or London purple will kill these insects.

7.—STRAWBERRY.

The strawberry is among the most largely grown truck crops of the State. The plants are everywhere in the State attacked by the disease called "leaf-rust." As this disease does not appear until after the fruit has been marketed most growers consider it of no great consequence. This is, however, a mistake. Plants attacked by rust during the summer will produce only feeble offsets and a smaller crop of fruit the succeeding spring.

The "rust" of the strawberry is caused by a parasitic fungus, *Sphaerella fragraiæ*. The spores of the fungus live through the winter in the dead and diseased leaves of last year's growth. They infect the new growth about the time the plants bloom, though the brown spots do not show on the leaves until later. Several crops of spores are matured during one season.

TREATMENT OF STRAWBERRY LEAF-RUST.

1. Mow off the entire leaf growth immediately after the first frost of the winter. Burn the mowings and mulch the plants with hay or straw.

2. As soon as the flowers fall in spring apply Formulas 2 or 4 and repeat in ten days. After the fruit has been gathered, repeat the treatment once a month until frost.

The strawberry grows naturally in shady woods, and hence when grown in open fields and kept free from weeds and grass it is very difficult to maintain the health of the plants. It would probably pay to plant a row of corn between each two rows of berries after the crop has been gathered. The corn will shade the berry plants.

For gnawing insects add to the formulas used for summer treatment the prescribed amount of arsenite, but no arsenite should be used for the spring treatment.

8.—TOMATOES.

North Carolina grows for market about 750 acres of tomatoes. The loss in recent years from rot has been so heavy that many truckers have given up the crop.

Tomato rot is caused by a parasitic fungus, *Macrosporium tomato*, assisted, more or less, by another fungus, *Cladosporum fulvum*.

TREATMENT OF TOMATO ROT.

1. Rotate crop so as to use the same ground not oftener than once in three years.

2. Plant tomatoes only on well drained ground.

3. Tie up the vines to posts or trellises so as to give plenty of air and sunlight.

4. Avoid putting much ammoniacal fertilizer on tomato ground.

5. Apply to plants in field, as soon as set out, Formulas Nos. 2, 4 or 5, and repeat every ten days until fruit begins to color.

6. Remove and destroy all rotten fruit as soon as found. Burn the old vines as soon as the crop is gathered.

The most troublesome insect enemies of the tomato are the boll-worm (now called tomato-worm) and the flea beetle. The tobacco worm attacks late tomatoes. The kerosene emulsion is the best remedy for these. The tobacco decoction may be used for the flea beetle. Paris green may be used until the fruit is half-grown, but not later.

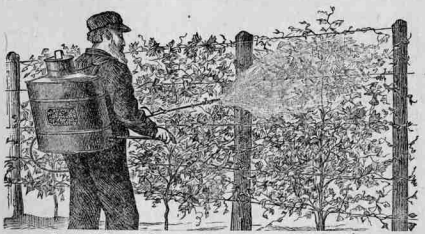

Fig. 33.—"EUREKA" KNAPSACK SPRAYER. See page 11 for description.

APPENDIX.

INSECTS BENEFICIAL TO TRUCK AND OTHER CROPS.

Insects are not altogether useless or noxious. They play a most important part in the fertilization of the ovules of many species of plants. There is a large class of rapacious and carnivorous insects which are, in an indirect way, extremely useful to all growers of plants, because they hunt out and destroy the eggs, larva or mature forms of noxious insects.

While waging a relentless warfare upon the insects which prey upon our crops, we should spare, encourage and protect our insect allies. These latter, as one might imagine from their predacious habits, are generally large and ferocious-looking, with powerful jaws for seizing and tearing their prey. In spraying with insecticides no discrimination can be made between friendly and injurious insects, but as the friendly insects are carnivorous and do not eat the foliage they are not hurt by Paris green or London purple. They are, however, killed by the kerosene emulsion and all insecticides which kill by touch. Many farmers who have to resort to hand-picking to save their crops, finding these ferocious looking, carnivorous insects more or less abundant upon the plants, conclude that these must be the parent forms of the lice or worms which do the damage. These, then, are carefully picked off and destroyed, in the belief that in this way the increase of the noxious insects may be prevented. This is a very unwise proceeding These ferocious-looking, predacious insects are among the farmer's best friends. Where they are present in considerable numbers the further increase, if not the reduction, of the noxious insects is assured with no cost to the farmer.

Among predacious insects none are more beneficial than the "lady-bugs," *Coccinella*, several species. These are the natural enemies of plant lice. The larva of the lady bug resembles a miniature alligator, and its appetite for plant lice is simply amazing. The lady bugs vary in color and size, but they are all small, and the usual colors are red, or pink spotted with black; black spotted with red, and yellow spotted with black.

The noxious cucumber beetle may be known from the true lady bug by its being *striped* instead of spotted. Lady bugs with us are never striped.

Fig. 19. SQUASH BORER.

The squash borer, *Diobrotica 12-punctata* (Fig. 19), resembles a lady bug, but it is larger and has long "feelers," which lady bugs have not. The Diabrotica is greenish-yellow, with black spots.

There is another insect closely related to the true lady bugs (Coccinella and Hippodamia), which feeds upon

Fig. 20. EPILACHNA BOREALIS.

cucumber and squash plants. This is *Epilachna borealis*, shown at Fig 20. It is of a reddish-yellow color, with seven black spots on each wing cover. It is much larger than the true lady-bug.

Fig. 21. 9-SPOTTED LADY BUG AND LARVA.

Among our most common and useful allies are the following:

The 9-spotted Lady-bug, *Coccinella novemnotata*, Fig. 21. This beetle is brick-red, with 9 black spots.

Fig. 22. 10-SPOTTED LADY BUG.

The 10-spotted Lady-bug, *Hippodamia maculata*, Fig. 21. This beetle is pink, with black spots.

Fig. 23. CONVERGENT LADY BUG. *a.* Larva. *b.* Pupa. *c.* Adult.

The convergent Lady-bug, *Hippodamia convergens*, Fig. 23. This is orange-red, with 13 small black spots.

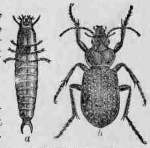

Fig. 24. THE FIERY GROUND BEETLE AND LARVA.

The Fiery Ground Beetle, *Calosoma calidum* (Fig. 24), is one of our largest, most beautiful, ferocious and rapacious insects. It feeds chiefly upon cutworms, but destroys vast numbers of cotton and boll-worms. This beetle is shining greenish-black, with golden dots in straight rows. It is most useful in the larva state.

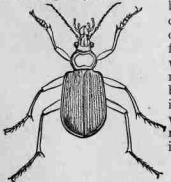

Fig. 25. GREEN GROUND BEETLE.

The Green Ground Beetle, *Calosoma scrutator* (Fig. 25), is one of our most common, elegant and useful insects. It is of a shining green color, without spots or stripes.

Fig. 26. THE MURKY GROUND BEETLE.

Fig. 27. LARVA OF MURKY GROUND BEETLE.

Figs. 26 and 27 show the Murky Ground Beetle, *Harpalus caliginosus*, and its larva. The beetle is of a blackish color. Of the exact size shown.

Fig. 28.—The Virginia Tiger Beetle.

Fig. 28 shows the Virginia Tiger Beetle, *Tetracha Virginica*. It is of a shining green color, with brown legs. Of the exact size shown.

Fig. 29.—Long Ground Beetle.

Fig. 29 shows the Elongated Ground Beetle. *Pasimachus elongatus*. It is of a shining black color, with dark-blue edge.

Fig. 30 shows the Banded Soldier Bug, *Milyas cinctnatus*. The line at the left shows exact size. This is one of our most elegant insects. The colors are black, white and yellow. It lives chiefly on trees, feeding upon worms and bugs it finds there.

Fig. 30.—Banded Soldier Bug.

Fig. 31.—Thick-thighed Soldier Bug.

Fig. 31 shows the Thick-thighed Soldier Bug, *Acanthocephala femorata*. This insect is very common in the South. It is of a black-brown color, sometimes inclining to red. It is of the exact size shown. Has a bad smell.

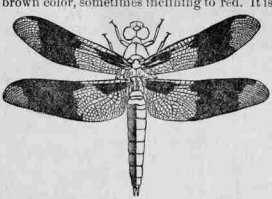

Fig. 32.—Dragon Fly.

Fig. 32 shows the Dragon Fly, or "Devil's Darning Needle," *Libellula trimaculata*. It is our swiftest flying insect. In the larva state it feeds upon mosquitoes; in the adult state it feeds upon many insects. It never harms human beings or animals. It should not be persecuted.

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Persons receiving this Bulletin are requested to notify the Station at Raleigh if the address is any way incorrect.